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Taxonomic structure and ecological analysis of plant cover of the alpine-subalpine landscapes of the Karabakh natural subregion (Lesser Caucasus)

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The orographic elements, vegetation cover of the alpine-subalpine zone, its taxonomic structure, and endemism of the Karabakh natural subregion were investigated. A total of 608 plant species (14% of Azerbaijan flora) belonging to 65 families and 253 genera are identified in the region. Of them, 353 species are wide areal plants, 255 are endemic species with different distribution statuses. *Asteraceae* (79), *Poaceae* (41), *Lamiaceae* (32), *Fabaceae* (31), *Rosaceae* (30), *Caryophyllaceae* (28), *Ranunculaceae (23), Brassicaceae (21), Apiaceae (25)* found in the region are dominant families. The 18 genera found in the area are sensitive and are represented by only one species in the flora of the region. *Asteraceae (67), Fabaceae (18), Apiaceae (18), Caryophyllaceae (17), Lamiaceae (14), Ranunculaceae (14), Brassicaceae (21)* are dominant endemic families. Among the endemic species, 13 are local endemic species native to Transcaucasus.

Keywords: *Karabakh natural subregion, biodiversity, alpine-subalpine landscapes, endemism, sensitive species*

INTRODUCTION

The study of the alpine and subalpine vegetation has a foundational role in ecology. Because, alpine-subalpine plants grow in harsh climatic conditions (low temperatures, prolonged frost, heavy snow accumulation, ultraviolet radiation, poor nutrition, wind), limit the vegetative period. These factors influence the plant population size. These data allow us to assess the climate change impacts on the population.

Located within the Caucasus Ecoregion, Karabakh natural subregion is considered an important area, due to its biodiversity, especially plant species. The region is known for its high endemism, and unfortunately, some of the plant species are at the edge of extinction due to afforestation, fires, excessive grazing, hybridization, and climate changes.

MATERIALS AND METHODS

Alpine and subalpine vegetation of the Karabakh natural subregion and their temporal changes are rarely studied and are concerns only some taxons (Hacıyev, 2004; Ibadullayeva et al., 2015; Əskərov, 2016; Aslanova, 2018). The main researches in this region were performed 30 years ago due to the occupation of these territories by the Armed Forces of Armenia. Therefore, our studies were carried out on plant diversity in other territories of the region – in high-mountains slopes of the Shahdagh, Shakarbeyli, Garaarkhaj, Garadag, Chanliyal ranges, and Goshgardag, Kapaz mountains. In assessing of biodiversity dynamics and status of the territory, used also the data of the last 70 years (Гроссгейм, 1955; Комаров, 1960). We also used data from online atlases and plant guides, such as Plantarium, Royal Botanic Gardens, World Plants, The Plant List, etc.

RESULTS AND DISCUSSION

The Karabakh natural subregion is located in the West part of Azerbaijan and in the South-West part of the Lesser Caucasus. The region consists of some orographic units such as Shahdag Range, Gokche Range, Karabagh volcanic Plateau,

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Karabakh Range, and some of the little ranges toward the different sites (Fig. 1). The subalpine landscapes in the Karabakh natural subregion are represented from the elevation of 1700-1800 m a.s.l to 2300-2400 m a.s.l. The alpine landscapes lie from 3200 m a.s.l. to 3500 m a.s.l. (Мусеибов, 2003; Məmmədov, 2015). The lower and upper boundaries of these landscapes and their transition depends on their altitude features and location. The transition from subalpine to alpine landscape is accompanied by ecotones – transition zones, where sparse and small trees and tall grasslands are replaced by low-statured, non-arboreal, and densely packed vegetation.

As seen in Fig.1 the Karabakh natural subregion is divided into 5 parts: 1. Shahdag Range and lateral ranges (Shakarbeyli, Garaarkhaj, Garadag, Chanliyal ranges and etc.); 2. Gokche Range; 3. Karabakh Range and lateral ranges (Ziyarat, Baghirkhan, Girkhgiz ranges, etc.); 4. Murov Ranges and lateral ranges (Gaflan-Gala, Bulagdagh, Goshgar, Pant, Gara Gaya ranges, etc.); 5. Karabakh Plateau and lateral ranges (Saribulagdag, Hochaz, Mikhtokan, Uzunyal, Eshek meydani, Chil Gaya, Khojayurd, etc.). Each of these parts has specific features of biodiversity.

The soils that are found in the alpine and subalpine belt of Karabakh natural subregion are mountain-meadow primitive, residually carbonate mountain-meadow, field mountain-meadow and mountain-meadow peat soils (Məmmədov, 2014).

The region also has a reach landscape diversity. Within this territory, there are two types of landscapes: high-mountain subalpine forest-shrub-meadow landscapes and high-mountain alpine shrub-meadow landscapes and 18 landscape species (Məmmədov, 2015; Əlizadə, 2017).



Fig. 1. Relief map of the Karabakh natural subregion

The plant taxonomy of Alpine and Subalpine vegetation of the Karabakh natural subregion is shown in Table 1.

According to the number of species leading families of Karabakh flora are: *Asteraceae* (79), *Lamiaceae* (32), *Rosaceae* (29), *Fabaceae* (29), *Caryophyllaceae* (28), *Ranunculaceae* (23), *Brassicaceae* (21), and *Apiaceae* (20) (Table 2). There are 25 dominant genera of alpine-subalpine landscapes in the region (Table 3). As seen from the Table *Campanula (Campanulaceae;* 25*), Carex (Cyperaceae;* 20*), Veronica (Plantaginaceae;* 16*), Senecio (Asteraceae;* 15*), Silene (Caryophyllaceae;* 15*)* are dominant plant families.

Table 1. Plant taxonomy of Alpine and Subalpine vegetation of the Karabakh natural subregion.

№	Class	Families, n		Genera, n		Species, n	
		Region	**Flora**	**Region**	**Flora**	**Region**	**Flora**
1.	*Lycopodiopsida*	1	2	1	2	1	2
2.	*Polypodiopsida*	4	6	9	24	11	55
3.	*Gnetopsida*	1	1	1	1	1	6
4.	*Pinopsida*	2	3	1	3	3	16
5.	*Liliopsida*	11	25	38	213	123	958
6.	*Magnoliopsida*	46	95	203	771	469	3351
Total:		**65**	**133**	**253**	**1015**	**608**	**4388**

There are 23 sensitive plant families represented by the only genera and species in the alpine-subalpine vegetation of the region (Table 4).

Table 2. Dominated families and its structure of alpine-subalpine flora of the Karabakh natural subregion.

№	Families	Genera, n		Spesies, n	
		in region	in flora	in region	in flora
	Polypodiopsida (11 species)				
1.	*Aspleniaceae*	5	10	7	21
	Liliopsida (113 species)				
1.	*Poaceae*	13	113	41	469
2.	*Cyperaceae*	5	19	17	116
3.	*Asparagaceae*	6	14	16	55
4.	*Orchidaceae*	4	20	12	62
5.	*Amaryllidaceae*	2	4	11	51
6.	*Liliaceae*	3	4	6	55
	Magnoliopsida (463 species)				
7.	*Asteraceae*	41	121	79	572
8.	*Lamiaceae*	14	37	32	219
9.	*Fabaceae*	10	43	31	293
10.	*Rosaceae*	11	33	30	216
11.	*Caryophyllaceae*	11	34	28	191
12.	*Ranunculaceae*	12	23	23	101
13.	*Brassicaceae*	14	82	21	245
14.	*Apiaceae*	11	70	20	182
15.	*Orobanchaceae*	6	16	18	73
16.	*Campanulaceae*	1	7	15	58
17.	*Plantaginaceae*	5	12	16	101
18.	*Gentianaceae*	4	6	10	22
19.	*Primulaceae*	3	8	10	27

Endemism of the territory. The number of endemic species in the flora of any area is an indicator of the specificity and uniqueness of the vegetation of that area. In the Caucasian flora described 1600 endemic plant species belonging to 13 endemic genera, which is about 25% of the total flora (Муртазалиев, 2012). Most of these species occur in high mountainous landscapes (Татанов, 2013; Shulkina et al., 2014; Zazanashvili et al., 2000).

Table 3. Distribution of the alpine-subalpine genera/ species of the region.

№	Genera	Families	Number of species		
			in the flora	in the region	%
	Liliopsida				
1.	*Carex*	*Cyperaceae*	116	12	10
2.	*Allium*	*Amaryllidaceae*	51	8	12
3.	*Ornitho-galum*	*Asparagaceae*	55	8	9
4.	*Iris*	*Iridaceae*	36	6	17
5.	*Alopecurus*	*Poaceae*	469	6	1
6.	*Poa*	*Poaceae*	469	6	1
7.	*Gagea*	*Liliaceae*	55	5	9
	Magnoliopsida				
8.	*Campanula*	*Campanulaceae*	60	15	25
9.	*Hieracium*	*Asteraceae*	572	11	2
10.	*Nepeta*	*Lamiaceae*	222	10	5
11.	*Veronica*	*Plantoginaceae*	101	10	10
12.	*Alchemilla*	*Rocaceae*	216	10	5
13.	*Saxifraga*	*Saxifragaceae*	14	9	64
14.	*Trifolium*	*Fabaceae*	293	9	3
15.	*Pyrethrum*	*Asteraceae*	572	8	1
16.	*Senecio*	*Asteraceae*	572	8	1
17.	*Ranunculus*	*Ranunculaceae*	101	7	7
18.	*Gentiana*	*Gentianaceae*	22	7	32
19.	*Psephellus*	*Asteraceae*	572	7	1
20.	*Heracleum*	*Apiaceae*	183	6	3
21.	*Anthemis*	*Asteraceae*	572	6	1
22.	*Tragopogon*	*Asteraceae*	572	6	1
23.	*Jurinea*	*Asteraceae*	572	5	1
24.	*Vicia*	*Fabaceae*	293	5	2
25.	*Thymus*	*Lamiaceae*	222	5	2

Table 4. Sensitive plant families represented in the region.

	Families	Family taxons			Status
		Genera	Species		
			Name	n	
1	2	3	4	5	6
	Lycopodiopsida				
1.	*Selaginellaceae*	*Selaginella*	*S.helvetica*	1	Widespread
	Polypodiopsida				
2.	*Alismataceae*	*Alisma*	*A. plantago – aquatica*	5	Widespread
3.	*Ophioglossaceae*	*Botrychium*	*B. lunaria*	4	Widespread
	Gnetopsida				
4.	*Ephedraceae*	*Ephedra*	*E.procera*	5	Widespread
	Pinopsida				
5.	*Taxaceae*	*Taxus*	*T.baccata*	1	Widespread

Table 4 continued

1	2	3	4	5	6
			Liliopsida		
6.	*Colchicaceae*	*Colchicum*	*C. speciosum*	11	Subendemic
7.	*Melanthiaceae*	*Veratrum*	*V. lobelianum*	2	Widespread
			Magnoliopsida		
8.	*Aceraceae*	*Acer*	*A. trautvetteri*	8	Subendemic
9.	*Fagaceae*	*Quercus*	*Q. macranthera*	9	Subendemic
10.	*Grossulariaceae*	*Ribes*	*R.orientale*	4	Widespread
11.	*Polygalaceae*	*Polygala*	*P. alpicola*	9	Caucasian endemic
12.	*Salicaceae*	*Salix*	*S. caucasica*	16	Subendemic
13.	*Celastraceae*	*Parnassia*	*P. palustris*	6	Widespread
14.	*Ceratophyllaceae*	*Ceratophyllum*	*C. demersum*	2	Widespread
15.	*Oxalidaceae*	*Oxalis*	*O. acetosella*	3	Widespread
16.	*Solanaceae*	*Solanum*	*S. persicum*	18	Widespread
17.	*Urticaceae*	*Urtica*	*U.dioica*	7	Widespread
18.	*Viburnaceae*	*Viburnum*	*V. lantana*	4	Widespread

n – number of species in the flora of Azerbaijan



Fig. 2. Characteristic plants of the alpine-subalpine flora of the Karabakh natural subregion:
Upper left: *Astrantia trifida* (Transcaucasica)
Upper right: *Campanula sibirica* (Wide areal)
Down left: *Linum hypericifolium* (North Caucasus, Transcaucasus, Turkey)
Down right: *Senecio sosnowskyi* (North Caucasus, Transcaucasus).

Table 5. Dominant plant families and their characteristics.

№	Families	In the flora, n	In landscapes			
			Total, n	Endems, n	%	Endemism, %
	Liliopsida					
1.	*Amaryllidaceae*	51	9	8	89	16
2.	*Poaceae*	469	33	7	21	1
3.	*Asparagaceae*	55	9	7	78	13
4.	*Iridaceae*	36	9	7	78	19
5.	*Liliaceae*	56	7	6	86	11
6.	*Orchidaceae*	62	12	4	33	6
	Magnoliopsida					
1.	*Asteraceae*	573	114	67	59	12
2.	*Fabaceae*	293	31	18	58	6
3.	*Apiaceae*	183	20	18	90	10
4.	*Caryophyllaceae*	191	27	17	63	9
5.	*Rosaceae*	216	30	15	50	6
6.	*Lamiaceae*	222	32	14	44	6
7.	*Ranunculaceae*	101	23	14	61	14
8.	*Brassicaceae*	245	22	10	45	4
9.	*Orobanchaceae*	73	18	8	44	11
10.	*Campanulaceae*	60	15	9	60	15
11.	*Plantaginaceae*	101	15	7	47	7

There are 296 endemic species with different distribution statuses in alpine-subalpine vegetation of the Karabakh Natural Subregion (Table 5). Of them 41 species in 8 families belong to *Liliopsid*a. Therefore, the originality of plant diversity of the region is about 7% of the total flora and about 50% of the landscape flora.

These species have different geographical areas and habitats. Some of them cover the entire Caucasus Ecoregion (North Caucasus, Transcaucasus, Turkey and Iran). The second group of species is widespread only in the North and South Caucasus. The third group of species is distributed in the same landscapes of the North Caucasus, Transcaucasus and Turkey. Finally, the fourth group of endemic species are found in the alpine-subalpine landscapes of the North Caucasus, Transcaucasus and Iran territories (Fig. 3, Table 6, Table 7).

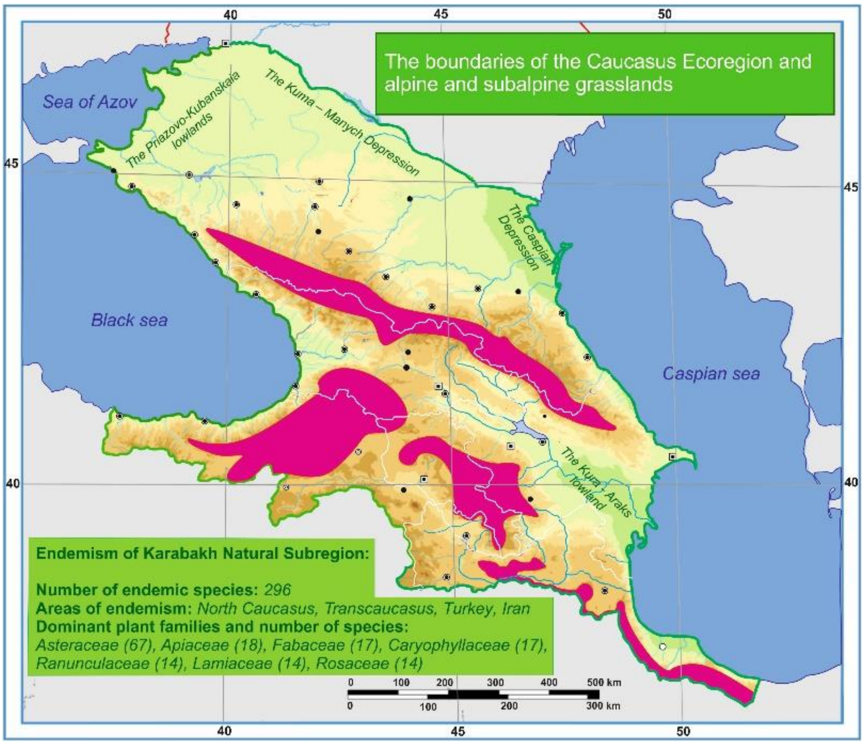


Fig. 3. Boundary of Caucasus Ecoregion and distribution of endemic plant species of the Karabakh Natural Subregion

Table 6. Distribution of dominant endemic families of Karabakh Natural Subregion within Caucasus Ecoregion.

Distribution of endemic species	Total number of species in the region	Number of endemic species in the families									
		Asteraceae	Apiaceae	Caryophyllaceae	Fabaceae	Ranunculaceae	Lamiaceae	Rosaceae	Brassicaceae	Campanulaceae	Orobanchaceae
North Caucasus, Transcaucasus	68	23	3	5	7	1	4	3	3	1	2
North Caucasus, Transcaucasus, Turkey	97	18	3	6	4	3	3	6	6	4	5
North Caucasus, Transcaucasus, Iran, Turkey	83	10	7	5	5	8	5	3	-	2	1
Transcaucasus	29	11	4	1	1	-	2	2	1	-	-
North Caucasus, Transcaucasus, Iran	19	5	1	-	1	2	-	1	-	2	-
Total	296	67	18	17	17	14	14	14	10	9	8

Table 7. Regional endemic (native to the Transcaucasus) plants occurring in the Karabakh Natural Subregion.

№	Families	Species
		Liliopsida
1.	*Iridaceae (3)*	*Iris caucasica* var. *multiflora, I.grossheimii, I.winogradowii*
		Magnoliopsida
2.	*Apiaceae (4)*	*Astrantia trifida, Carum komarovii (Aegopodium komarovii), Heracleum schelkovnikowii, H.albovii*
3.	*Asteraceae (11)*	*Echinops pungens (E.szowitsii), Hieracium karjaginii (H.levicaule* supsp. *karjaginii), Jurinea blanda, J.grossheimii, J. praetermissa, J.spectabilis, Lactuca kirpicznikovii, Psephellus karabaghensis, P. transcaucasicus, P.komarovii (Tanacetum zangezuricum), Scorzonera kirpicznikovii*
4.	*Brassicaceae (1)*	*Alyssum globosum (Takhtajaniella globosa)*
5.	*Caprifoliaceae (1)*	*Cephalaria armeniaca*
6.	*Caryophyllaceae (1)*	*Silene depressa*
7.	*Fabaceae (1)*	*Lathyrus ciliatidentatus*
8.	*Lamiaceae (2)*	*Ajuga oblongata, Scutellaria sevanensis*
9.	*Linaceae (1)*	*Linum subbiflorum*
10.	*Papavearceae (1)*	*Papaver zangesurum*
11.	*Plantaginaceae (1)*	*Linaria schelkownikowii (L.grossheimii)*
12.	*Rosaceae (2)*	*Alchemilla epipsila, Rosa isaevii*
13.	*Thymelaceae (1)*	*Daphne axilliflora*

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Qarabağ Təbii Yarımvilayətinin subalp-alp landşaftlarının bitki örtüyünün taksonomik strukturu və ekoloji analızı (Kiçik Qafqaz Təbii Vilayəti daxilində)

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Qarabağ təbii yarımvilayətinin oroqrafik elementləri, ərazinin alp-subalp landşaftlarının bitki müxtəlifliyi, taksonomik strukturu, endemizmi araşdırılmışdır. Ərazidə 65 fəsilə, 253 cinsə aid 608 bitki növü müəyyən edilmişdir. Azərbaycan florasının 14%-ni təşkil edən bu növlərdən 312 növ geniş areallı, 296 növ isə müxtəlif statuslu endem növlərdir. Fəsilələr arasında *Asteraceae* (79), *Poaceae* (41), *Lamiaceae* (32), *Fabaceae* (31), *Rosaceae* (30), *Caryophyllaceae* (28), *Ranunculaceae (23), Brassicaceae (21), Apiaceae (25)* fəsilələri dominant fəsilələrdir. Ərazidə rast gəlinən 18 fəsilə həssas fəsilələr olub region florasında yalnız 1 növ ilə təmsil olunur. *Asteraceae (67), Fabaceae (18), Apiaceae (18), Caryophyllaceae (17), Lamiaceae (14), Ranunculaceae (14), Brassicaceae (21)* endem növlərin sayına görə dominant fəsilələrdir. Endem növlərdən 13 növ regional endem növ olub Cənubi Qafqaz endemləridir. Burada *Asteraceae (11), Apiaceae (4) və Iridaceae (3)* fəsilələri üstünlük təşkil edir.

Açar sözlər: *Qarabağ təbii subregionu, bioloji müxtəliflik, flora, alp, subalp, endemizm, həssas növlər*

Таксономическая структура и экологический анализ растительности альпийско-субальпийских ландшафтов Карабахской Природной Области (Малый Кавказ)

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Изучены орографические элементы, видовой состав, таксономическая структура, эндемизм растений альпийско-субальпийских ландшафтов Карабахской природной области. На территории выявлены 608 видов растений, относящихся к 65 семействам и 253 родам. Из этих видов, которые составляют 14% флоры Азербайджана, 312 являются широкоареальными видами, а 296 - эндемичные виды с различным статусом. Семейства *Asteraceae* (79), *Poaceae* (41), *Lamiaceae* (32), *Fabaceae* (31), *Rosaceae* (30), *Caryophyllaceae* (28), *Ranunculaceae* (23), *Brassicaceae* (21), *Apiaceae* (25) являются доминантными. Среди семейств, встречающихся в регионе, 18 являются чувствительными семействами и представлены единственным видом. *Asteraceae* (67), *Fabaceae* (18), *Apiaceae* (18), *Caryophyllaceae* (17), *Lamiaceae* (14), *Ranunculaceae* (14), *Brassicaceae* (21) являются доминирующими эндемичными семействами. Из эндемичных видов встречающиеся в регионе 13 видов являются региональными эндемиками т.е. эндемиками Южного Кавказа. Среди них *Asteraceae* (11), *Apiaceae* (4) и *Iridaceae* (3) доминируют.

Ключевые слова: *Карабахская природная область, биологическое разнообразие, флора, альпийский, субальпийский, эндемизм, чувствительные виды*